

Research Note 80-29

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UTILIZATION OF TACTICAL COMPUTERS  
FOR TRAINING:

ANALYSIS OF SYSTEM AND TRAINING  
REQUIREMENTS

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System Development Corporation

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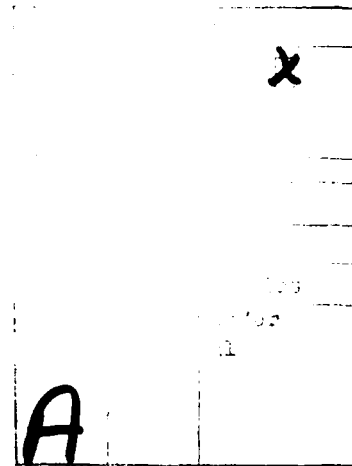
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**UTILIZATION OF TACTICAL COMPUTERS  
FOR TRAINING: ANALYSIS OF SYSTEM  
AND TRAINING REQUIREMENTS.**

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## I. INTRODUCTION

This Research Note, Utilization of Tactical Computers for Training: Analysis of System and Training Requirements, describes Phase V in the development of TACFIRE Automated Instruction (AI) courseware. Figure 1 depicts the five phases that constitute the total project effort.

The overall project aim is to extend the scope of the application of computer-assisted interaction (CAI) to the development of self-instructive programs and procedures for users of tactical data processing systems. The basic approach is to provide AI training subsystem packages which can be run on the operating system and, when not used for tactical operations, to provide initial and refresher training in system use. The overall objective of this work effort is the development of stand alone CAI courseware appropriate to the training of users of the TACFIRE System. Project products will provide the foundation for subsequent evaluation and refinement of CAI technology as applied to training in tactical systems.

The purpose of Phase I is to: (1) review TACFIRE documentation; (2) summarize the salient features of the TACFIRE System pertinent to the applications of AI in tactical ADP units; (3) review PLANIT documentation to determine the characteristics and limitations imposed by its use in the TACFIRE System; (4) select preliminary functions for AI training; (5) provide a rationale for the particular instructional strategy selected; (6) discuss other facets of educational technology germane to the use of AI in tactical systems which, because of time and other limitations, could not be examined in the present study.

The selection of preliminary functions for AI training will be reviewed by the U.S. Army Research Institute and other designated agencies for the purpose of selecting the final topics for AI training. The final topics selected will form the basis for Phase II of this project: Perform Job/Task and Training Analysis.



Phase I - Analyze System and Training Requirements

Phase II - Perform Job/Task and Training Analysis

Phase III - Develop Courseware

Phase IV - Install Courseware

Phase V - Develop Field Evaluation Plan

Figure 1. Utilization of Tactical Computers for Training:  
Major Project Phases

## II. REVIEW OF TACFIRE DOCUMENTATION

This report is based upon an analysis of the available TACFIRE documentation (Appendix A) and the system engineering of TACFIRE training documentation available to date at the U.S. Army Field Artillery School, Fort Sill, Oklahoma (Appendix A); discussions with TACFIRE personnel at the U.S. Army Field Artillery School and at the U.S. Army Research Institute for the Behavioral and Social Sciences, Arlington, Virginia; and initial familiarization and briefings on the TACFIRE equipment at the CSC MELPAR facility and at the U.S. Army Field Artillery School.

In selecting preliminary functions for training, the documentation noted above was reviewed and analyzed. The DTM 11-7440-240-10 series (Appendix A), which covers battalion TACFIRE operations, noted the following major operational topics for consideration:

### ACC Operation

- Initialization and Preparation for Use (SYS;)
- Battalion Support Function (SPRT;)
- Battalion Meteorological Function (MET;)
- Battalion Fire Support Officer Function (SYS;)
- Battalion Tactical and Technical Fire Control (FM;)
- Battalion Non-nuclear Fire Plan Function (NNFP;)
- Battalion Artillery Target Intelligence Function (ATI;)
- Battalion Survey Function (SURV;)

The task list prepared by the USAFAS for the Battalion Operations Center Direct Support Field Artillery Battalion was also reviewed. The major operational topics noted for consideration are:

- Operate the Artillery Control Console (ACC)
- Initialize the Operating System
- Initialize the Maneuver Battalion and Brigade Fire Support Officers
- Prepare the Variable Format Message Entry Device for Operation

- Operate the Variable Format Message Entry Device
- Establish Tactical Data Base
- Conduct Fire Mission Operations
- Conduct Quick Response Fire Missions
- Conduct Registrations
- Conduct Special Fire Missions
- Counterfire Operations
- Conduct Intelligence Operations
- Conduct Fire Planning
- Prepare and Process Situation Reports
- Perform File Maintenance and Update Procedures
- Conduct Survey Operations

The TACFIRE computerized system provides rapid and accurate transmission and utilization of field artillery data. The TACFIRE system is based upon the manual field artillery system in that the data, operations and procedures evolve from the manual system. To operate most effectively, TACFIRE requires that the data bases be fully established prior to operations. In the manual system, data in the data bases are considered and decisions to use or ignore the data are based upon operator considerations, with the effects being overtly evident and manually controlled or adjusted. In TACFIRE, the effects are somewhat obscure and become evident when missions are processed and fired. The interactive effects are less readily known and compensation for them requires extensive knowledge of system operation. The speed at which decisions are implemented is increased, as are also the effects of implementing wrong decisions.

TACFIRE is a complex system. Computerized control, as programmed in TACFIRE, involves a great deal of specificity: precise inputs, and the filling in of required fields and subfields that allows little margin for error. The formats used are many and varied and the data entries required for each format are extensive and precise. On the surface it appears a formidable learning task

requiring a retentive memory and extensive memory span. If the system were learned in this fashion, such would indeed be the case.

However, closer examination of the TACFIRE System shows that the procedures, data base, nomenclature and requirements closely parallel the manual fire direction system. The difference in the computerized TACFIRE System is that data formerly considered implicitly must now be considered explicitly, i.e., formulated and stated in advance and input into the operational data base. The first problem manifests itself in format requirements for inputting the data and the precise form the data will take: sources of data remain the same as in those in the manual system.

A second consideration is the determination of the relative criticality of certain TACFIRE aspects. Given that the computer is functioning properly, the critical aspects of TACFIRE follow closely the critical aspects of the manual system: Data are required which will (1) locate the target, the guns, and usually the forward observer, so that effective fire and adjustment of fire can be accomplished; (2) detail the gun, target, and ammunition characteristics; (3) describe procedures and methods of communication. In essence, therefore, TACFIRE procedures and manual procedures are the same, the difference being that the computer is used as a means to transmit data, compute fire orders, and initiate and maintain the recordkeeping and updating functions of the various data bases. Training focus, then, is one the computerized conduct of these activities.

Many varied sources of data constitute the TACFIRE data bases--guns, ammo, target, meteorological, etc. These data are input from different units and agencies, either directly into the computer or by oral or written data reporting. Consequently, much of the TACFIRE operation involves the processing--rather than the generation--of data. The operational problem becomes one of transposing data in oral or written form into the precise format required for computer entry. This is a TACFIRE training problem. Another problem is the

assurance that all required data are entered. This is partly a TACFIRE training problem but primarily a field artillery problem, e.g., all required data should be provided in a request for fire. When computerized data are incomplete, the question arises as to whether data were simply missing or were input incorrectly. It is assumed that because TACFIRE operations personnel are field artillery-trained, they will recognize when data are missing. TACFIRE training will cover the correct input of data. Carrying this a step further, it is assumed for the purposes of this project that TACFIRE students are skilled field artillery personnel and will not require training in manual field artillery operations and procedures as part of the TACFIRE AI training.

Over 100 of the TACFIRE formats are shown in Figure 2. Most formats require the entry of different types of data and completion of specific field or combinations of fields for valid entry. Valid entries in most instances are those required in manual field artillery fire direction and control. The TACFIRE training problem thus becomes one of associating input data with a specific format, calling up the format, making the entries and transmitting the data to the units or organization requiring them, e.g., from Bn FDC to Divarty FDC. Approached in this way, the training task becomes one of associating specific types of inputs with specific types of formats and attending to the input requirements specified to a considerable degree by the format itself.

Much of the training problem can be alleviated by maintaining the job orientation, i.e., teach the individual in the context in which he will do the job, integrating TACFIRE-specific operations and procedure into the overall known task of carrying out the field artillery mission. This builds upon what the student already knows by providing a training program geared to the way in which he will do the job and using the job situation to determine what and when he will learn. This is known as functional context training. This and other instructional strategy to be used is discussed in Section VI.

TTFC function (Fire Mission)	Ammunition and Fire Unit Function	Survey Function
FM;DIR	AFU;DIR	SURV;DIR
FM;RFAF	AFU;UPDATE	SURV;TPAC
FM;SUB	AFU;BAMOUN	SURV;SCPST
FM;QF	AFU;MV	SURV;SVTP
FM;NUKE	AFU;MASK	SURV;TPR
FM;INTM	AFU;REG	SURV;CRITER
FM;HBMPI	AFU;AMOL	SURV;PRTSVY
FM;OBCO	AFU;ASR	SURV;SEND
FM;COMD	AFU;MFR	SURV;DELET
FM;MOD	AFU;MFN	SURV;AZDIST
FM;FUSEL	AFU;BUILD	SURV;AZALT
FM;XCLUDE	AFU;COMD	SURV;AZHR
FM;ATTACK		SURV;FAZ
FM;FC } output		SURV;TRAV
FM;EOM } by		SURV;TRADJ
FM;CHECK) computer		SURV;CCC
	Support Function	SURV;INTER
Non-nuclear Fire Plan Function	SPRT;DIR	SURV;TRIANG
	SPRT;MAP	SURV;SINT
	SPRT;DPM	SURV;TRILAT
	SPRT;GEOM	SURV;RE2
	SPRT;ZNE	SURV;RE3
	SPRT;AIRCOR	
	SPRT;COMD	
NNFP;DIR		Meteorological Function
NNFP;COMFP		MET;DIR
NNFP;INST		MET;CM
NNFP;RESFU		MET;CW
NNFP;FPTU		MET;COMD
NNFP;FPA		
NNFP;EXECFP		
NNFP;COMD		
NNFP;MOD		
NNFP;FUSEL		
NNFP;XCLUDE		
NNFP;ATTACK		
Artillery Target Intelligence Function		
	System Function	
ATI;DIR	SYS;DIR	
ATI;CDR	SYS;PDS	
ATI;AZR	SYS;FCM	
ATI;SHR	SYS;PCLD	
ATI;MFR	SYS;SBT	
ATI;SVL	SYS;LGSB	
ATI;CBTI	SYS;AUTH	
ATI;QUERY	SYS;COMSEC	
ATI;SRI	SYS;ADDR	
ATI;PREFP	SYS;INIT	
	SYS;MISC	
	SYS;PTM	
	SYS;FORM	
	SYS;MDS	
	SYS;FSO	
	SYS;RD } COMM messages	
	SYS;CED } to	
	SYS;NORM) computer	

Figure 2. TACFIRE Message Formats

In summary, the training problems which become evident when the new TACFIRE computerized system is overlayed on the known current manual system are:

1. Learning the TACFIRE-specific operations, procedures and restrictions.
2. Integrating manual field artillery operations, procedures and data, i.e., essentially learning when, where, and in what sequence they are used (e.g., what formats are required to carry out a fire mission).
3. Learning to operate at the high level of specificity, e.g., target designation, and extremely precise procedures required by the computer system.
4. Learning the procedures required when "normal" TACFIRE procedures do not result in mission accomplishment. These are the steps required to circumvent problem situations. In many cases, similar data in the manual system would be considered mentally and quickly revised or ignored; the TACFIRE System, however, requires specific computer actions that initially appear time-consuming but are actually more effective in terms of overall system operation.

### III. SUMMARY OF THE TACFIRE SYSTEM FEATURES APPLICABLE TO AI IN TACTICAL ADP UNITS

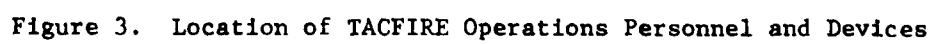
The TACFIRE System is an automatic data processing system used in artillery fire planning, fire mission processing, and supporting tasks. The system comprises computer centers for DivArty FDCs (Division Artillery Fire Direction Centers) and field artillery Bn FDCs, remote devices for field artillery missile unit FDCs, fire support elements (FSE) at the division command post, fire support officers (FSOs) at supported maneuver battalion and brigade command posts, forward observers (FOs) and firing batteries.

The DivArty FDC is the central data processing point for the system. Bn FDCs are also data processing points for the artillery battalions but rely on the DivArty FDC for tactical coordination and planning assistance. Additionally, the division FSE uses DivArty data processing capabilities for fire support coordination, computations and determinations.

From an operator standpoint, three basic devices are used to communicate with, provide inputs to, and/or modify data in the TACFIRE System. These are: (1) the artillery control console (ACC), which is part of the computer and display group in the Bn and DivArty FDCs; (2) the VFMED (Variable Format Message Entry Device) used by FSOs and FSE personnel, and (3) the FFMED (Fixed Format Message Entry Device) used by FOs. The FFMED can transmit (input) only. Figure 3 depicts the location of relevant operations personnel and devices.

Devices which only receive and print or display in the TACFIRE System are: the digital plotter map (DPM) and electronic line printer (FLP), which are output (only) devices in the FDCs; the BDU (battery display unit) at the firing battery, which receives (only) firing commands from the Bn FDC; and the ETD (electronic tactical display) at the DivArty FDC. Each of these devices is controlled by operator action at the ACC.





Although a computerized system, TACFIRE is based upon the manual field artillery system. Functions of personnel, decisions made, factors considered in making decisions, the types of data acted upon, the reporting required and update of data are the same for TACFIRE as for the manual system. The difference is that the computer provides for the accurate and rapid processing and transmission of data processing of the fire mission request, calculation of the ballistics solutions, and reminders (warnings) when commander guidance or troop safety limits are exceeded. In order to attain this increased capability, data bases must be constructed in advance and computer format, input requirements and procedures strictly adhered to.

#### IV. REVIEW OF PLANIT CHARACTERISTICS AND OPERATING LIMITATIONS IN TACFIRE

##### A. PLANIT CHARACTERISTICS

PLANIT is the CAI system specified for use in TACFIRE automated instruction (AI). PLANIT is an extremely versatile CAI system which lends itself to TACFIRE requirements for course development, course modification and student interaction. PLANIT courseware can be administered by the author in any stage of its development. Moreover, a complete range of error diagnostics is provided by PLANIT during the operation of the instructional program. Thus the courseware can be edited on line at any time during its construction or operation, accommodating changes to both instructional strategy or course content.

PLANIT has built-in student response processing functions that enhance student interaction. A number of correct and incorrect responses can be programmed for the same question, with feedback and branching to additional course materials appropriate to the skills and knowledge shown by the response. A phoetic comparison capability (PHONETIC) detects words in the response that sound like the prescribed answer but may be spelled differently. A "key word" machine routine (KEYWORD) requires only that words of the prescribed answer be found embedded in the student's response. The sequence control function, WAIT, is used to limit the time that a student has to respond and to prompt the student accordingly.

The PLANIT version to be used with TACFIRE AI is version 2.6. Initial review of PLANIT 2.6 and discussions with ARI personnel indicate all the PLANIT operational functions, including the above examples, will be available for TACFIRE courseware development.

## B. OPERATING LIMITATIONS IN TACFIRE

PLANIT installation on the TACFIRE L-3050 System imposes some operating limitations (parameters) for courseware development. These involve the display limitations of the ACC and VFMED CRT displays, frame characteristics, character set, and operational environment (geometry).

The ACC and VFMED CRT display size is seven lines with 72 characters per line. Display size of courseware will be six lines (lines 2 through 7) with up to 70 characters per line. (Note: In some cases, TACFIRE formats are seven lines). Student response will be entered on line 1.

The frame characteristics (maximum parameters) are as follows:

Frames:	101 per lesson
Characters per frame:	1280 (frame buffer size)
Labels:	44 per lesson
Items:	64
Matrix size:	400 cells
On-line users:	depends on available consoles (1 ACC and up to 8 VFMEDS)

The asterisk from PLANIT (to designate the requirement for a response) will not be used. To suppress the asterisk, the \$ facility available in PLANIT will be used for each frame. A bookkeeping problem during courseware development will be to make the presentations and feedback even so that subsequent presentations are not forced out of synch due to variable feedback. For example, if a frame presentation of six lines has four feedback messages, each feedback message must take up the same number of lines (either text or use of line skips) so the next frame presentation will look the same regardless of which feedback message was presented to the student.

The character set to be used will be the same as for the IBM 029 keypunch. Courseware will be produced on cards using this character set for conversion by ARI to tape for loading into PLANIT on the TACFIRE System.

The operational environment (geometry) to be used in courseware development is the scenario prepared by the U.S. Army Field Artillery School for TACFIRE training. Ballistic solutions and computer selections and warnings for various target locations for each battery will be obtained from the USAFAS to provide realistic inputs and correct data for course material construction.

## V. SELECTION OF PRELIMINARY FUNCTIONS FOR AI TRAINING

### A. SELECTION CRITERIA

The selection of preliminary functions for AI training is based upon an analysis of the TACFIRE documentation; the system engineering of training documentation prepared by the U.S. Army Field Artillery School, including draft tasks lists and Battalion Program of Instruction (POI); discussions with TACFIRE personnel at USAFAS and with ARI personnel responsible for the TACFIRE project; and demonstrations of TACFIRE equipment operation at the Computer System Command MELPAR facility and at the U.S. Army Field Artillery School.

As stated earlier, the purpose of this project is to demonstrate and evaluate the potential for utilizing tactical computers, when not required for tactical operations, to meet general and specific needs of system users of tactical units.

In order to demonstrate the potential for utilizing tactical computers for training, the following criteria and considerations were established as the basis for selection of preliminary functions for AI training:

- Function is critical to tactical operations
- Function is performed frequently
- Function is performed by a significant number of operations personnel
- Functions selected provide a breadth of coverage
- Functions provide continuity within the AI training program; i.e., provide modular independent blocks of instruction. Each modular block should have a specific beginning, a specific end and logical continuity throughout.

These criteria furnish the basis for the selection process which follows.

#### B. AREAS, PERSONNEL AND EQUIPMENT CONSIDERED

In the review of TACFIRE documentation and discussions with TACFIRE personnel, it is evident that many of the functions performed at the DivArty FDC and Bn FDC are similar. The major differences, as shown by the USAFAS task lists, are in the intelligence functions at division level and the execution of fire missions at battalion level. Consequently, in selecting preliminary functions for training, the area considered is the Bn FDC sphere of operations, which also covers many functions of the DivArty FDC.

In the TACFIRE Bn FDC an almost complete overlap exists between the tasks for the Fire Direction Officer (FDO) and the Fire Direction Sergeant in that the task lists for the Fire Direction Sergeant cover most of the tasks for the FDO. It is recognized that the responsibility for operations and decision making rest with the FDO. However, the TACFIRE operational knowledge and skills apply to both. Modules developed for these tasks will also not only apply to Bn FDC personnel but will have a fairly wide range of application by applying to DivArty personnel as well.

As for the equipments involved, these are the ACC console, the VFMED, and the FFMED. Because the FFMED is being redesigned and data are unavailable, it has been dropped from consideration. The ACC console is used at both Bn and DivArty FDCs, and the VFMED is used by FSOs and division FSE. The ACC console and VFMED operation, consequently, are the areas for consideration.

In summary, the preliminary functions selected for AI training cover the Bn ACC console operation by the Bn FDO and Fire Direction Sergeant and the VFMED operation by the Bn FSO.

### C. PRELIMINARY SELECTION OF FUNCTIONS---ACC

Fire direction is the tactical employment of fire power. Fire direction includes both tactical fire direction and technical fire direction. Tactical fire direction is the exercise of tactical command of one or more units in the selection of targets, the designation of units to fire, and the allocation of ammunition for each mission. Technical fire direction is the conversion of calls for fire to appropriate fire data and fire commands. In TACFIRE computer operations, both tactical and technical fire direction are conducted simultaneously by computer action at the ACC.

Nonetheless, TACFIRE can be regarded as two general areas. The first is the processing of fire missions, production of firing data, and the recording and reporting of fire missions. The second is the maintaining and updating of the data bases that permit tactical and technical fire direction to be accomplished. Both areas have been considered in the selection of preliminary functions for AI training.

#### 1. Conduct of the Fire Mission

The functions for conducting fire missions were selected first. Many--if not most--fire missions will be processed simply and quickly. The first module proposed will cover the conduct of the fire mission. Segment 1 of this first module will cover a simple fire mission in the automatic mode. The actions and results required, with the console actions and formats to be learned, are shown in Figure 4.

This first segment serves as an introduction to TACFIRE, showing the speed and simplicity with which fire missions are carried out. It provides initial experience with the ACC console in a normal job environment situation. Console actions and formats are learned and carried out as the situation requires.



<u>Action</u>	<u>Result</u>
<u>Request for Fire Mission</u>	
1. FO enters request on FMED.	Message Status Line will be updated.
2. Message displayed on RD by processing PRIORITY MESSAGE (or CYCLE MESSAGES).	FM;RFAF Format.
3. Press PAGE.	Segment 2 - fire command (no warning messages generated).
4. Press PAGE to see other segments.	Last segment is repeat of Segment 1.
5. Press RD XMIT (no changes).	FM;FC segments transmitted.
<u>Adjust Fire</u>	
6. FO requests adjust fire (automatic processing).	Message status line updated. FC transmitted automatically to BDU. FC printed on ELP.
<u>Fire for Effect</u>	
7. FO enters FFE in CONT; field, of FM;SUBS.	FC transmitted automatically. FC printed on ELP.
<u>End of Mission</u>	
8. FO enters EOM in FM;SUBS.	FM;EOM output message sent to BDU. ATU;MFR is generated by computer and output to ELP and ACC receive queue.
9. Press PRIORITY MESSAGE (or CYCLE MESSAGE) to obtain AFU;MFR. Review and update. Press RD CMPTR ACTION.	ATU;MFR will be transferred to DivArty.

Figure 4. Conduct of a Simple Fire Mission (automatic mode)

The next segment provides the complete processing of another fire mission, this time in the manual mode. Warning and error messages and modification of the FM;RFAF are included. Console actions and formats are learned as they are introduced; actions which are repeated from the first segment are reinforced.

The third segment covers fire missions requiring request for fire from DivArty. The complete fire mission from the initial FO message to EOM is included. New console actions and formats required are learned as they are introduced; skills and knowledge learned from segments 1 and 2 are reinforced.

In the three segments for module 1, the student learns the TACFIRE procedures required to obtain and check the request for fire (including troop safety), transmit the fire order to the battery, receive and transmit adjust fire and fire for effect, end the mission, report the results and update the ammunition status. Console actions learned in the first module include the following SPA switch actions: PRIORITY MESSAGE, CYCLE MESSAGES, PAGE, RD CMPTR ACTION, TRANSFER TO EDIT, RD XMIT, C/ED CMPTR ACTION, REPLACE, FORMAT COMMAND and initial use of the format command matrix switches A through H and 1 through 8. This baseline module provides a framework for other TACFIRE operations. It should be noted that if the TACFIRE data bases have been correctly established and sound artillery tactical practices have been followed in regard to gun, target, ammunition and other elements, most TACFIRE fire missions should be processed as simply and quickly as those in this first module. The module also provides initial experience with TACFIRE within a very familiar situation--conduct of a fire mission--with the added effect of showing how quickly and easily TACFIRE fire missions can be accomplished.

In selecting additional preliminary functions for conducting fire missions, the functions and message formats in the DTM 11-7440-240-10 volumes (which cover the same areas as the USAFAS task lists) were reviewed. The two areas directly applicable to the conduct of fire missions in the ACC operation are

FM and NNFP. Within these two areas, each TACFIRE message format (see Figure 2) was reviewed as to content, purpose, description, and relationship between messages.

The content and procedures in the conduct of the Fire Mission (FM) and the Non-Nuclear Fire Plan (NNFP) are similar. In some instances, the message content and purpose are almost the same. However, the Fire Plan Function is a complete entity in itself and a culmination of applications of prior learning. It is anticipated that a partial coverage of this area is inappropriate and would be difficult for the student to understand unless a full treatment were given and a base of knowledge first established. Because the amount of AI courseware is limited and the FM function and other functions selected cover many of the same skills and knowledge, the NNFP function has been dropped from consideration.

The messages for the FM function were reviewed for content, description of function, complexity, relationships, use and frequency of use in carrying out the fire mission in a tactical (job) situation. Based upon these considerations, the functions recommended for preliminary consideration are:

- FM;DIR - Fire Mission message directory
- FM;RFAF - Fire Mission - request for additional fire
- FM;SUBS - Subsequent commands
- FM;QF - Quick response fire request
- FM;OBCO - Observer location
- FM;COMD - User commands
- FM;FC - Fire command
- FM;EOM - End of mission
- FM;CHECK - Check firing

The last three are output messages generated by the computer in response to input messages.

## 2. Maintaining and Updating Data Bases

The second general area is the maintaining and updating of the data bases that permit tactical and technical fire direction to take place in the computerized TACFIRE environment. Many of these functions (SPRT; AFL; MET; ATI; SURV;) require the same set of skills and knowledges:

- Receive the message input
- Associate the message with the format required
- Display the format required
- Convert the data into the message format
- Enter the data into the data base
- Transmit messages to appropriate agencies

In some cases, data are received by digital transmission and automatically converted into message formats. In other cases they are not, in which instances the display of the format provides cues as to the data entered. For example, in the use of the SPRT;MAP format to establish the MAP MOD during initialization, FAST and NORTH refer to Easting (meters) and Northing (meters) with space for two, six-digit entries on each. These are for the most eastern and western edge and the most northern and southern edge. The data received for EAST and NORTH will be in meters and not exceed six digits. In order to adequately position the boundaries, the GZ (grid zone) must also be specified. The data received are, in many cases, the same as the data to be entered. Field artillery personnel at the FDC operations level are accustomed to thinking in these terms. When they do not, the error and warning messages provide further cues as to what is needed.

The training requirement, then, is to associate the incoming message with the format required, associate the message entries with the format entries and interpret the error messages as they occur.

If the skills and knowledges are the same for the five functions (SPRT; AFU; MET; ATI; SURV;) given above, then selection of preliminary functions for AI training depends upon which functions are more critical for fire direction. Based on this consideration, the functions recommended are ATI, AFU, and SPRT. Within these areas, the following are recommended:

- ATI;DIR - Artillery target intelligence directory
- ATI;CDR - Coordinate report
- ATI;SRI - Standing request for information
  
- AFU;DIR - Ammunition and fire unit directory
- AFU;UPDATE - Fire unit update
- AFU;BAMOUNP - Fire unit ammunition update
- AFU;MV - Current muzzle velocity specification
- AFU;AMOL - Critical ammunition level
- AFU;ASR - Available supply rate
- AFU;MFR - Non-nuclear mission fired report
  
- SPRT;DIR - Support message directory
- SPRT;MAP - Map modification
- SPRT;DPM - DPM orientation
- SPRT;GEOM - Alter geometry file
- SPRT;CMD - User commands

The continuity between topics is maintained by an underlying developing tactical situation. New console actions required are learned as they are used. Actions required are carried through to completion, including requirements to transmit changes to other agencies.

### 3. System Functions

The last ACC area to be considered is the system operating messages (SYS) used to initialize and update the FDC files for operation within the FDC and with other subscribers. These include the establishment of subscriber tables, addresses and message addresses. Considered for inclusion are the following:

- SYS;DIR - Operating system message directory
- SYS;PDS - Peripheral device status
- SYS;FCM - Format/command matrix
- SYS;SBT - Subscriber table
- SYS;FSO - Fire support officer
- SYS;PCLD - Priority, classification, logging and display
- SYS;LGSB - Legal message type per subscriber
- SYS;ADDR - Address
- SYS;INIT - Initialization
- SYS;FORM - Format skeleton request

This module will also be developed in terms of the tactical (job) situation, showing the console actions and procedures required and the interrelationship between the system messages.

#### D. PRELIMINARY SELECTIONS OF FUNCTIONS-VFMD

In selecting preliminary functions for the Bn FSO VFMD operation, the same considerations apply as for the ACC, particularly in the maintenance of job relationship - functional context training.

In the Bn FSO operation, data of interest to the Bn FSO is received from the Bn FDC. These include data from all the major functions, ATI; AFU; etc., which are relative to his area of operations. The task of the Bn FSO in this situation is to receive and interpret the data contained in the message formats. The data in the formats are, for the most part, recognizable by the FSO based upon his field artillery experience.

The Bn FSO also transmits data to the Bn FDC, including ATI; SPRT; NNFP; etc., by requesting the message format skeleton from the FDC through the SYS;FORM function. The task of the Bn FSO in this situation is to obtain the appropriate message format, enter the data appropriately to meet the computer conditions for precise formatting and the completeness and legality of the various combinations of entries, and transmit the data. In addition, he interprets the error messages when the data entered do not meet requirements for entering data.

The FSO is particularly concerned with the FM-related functions, including the monitoring of FO requests for fire with the prerogative of stopping the fire mission (check fire) through the FM;CMD or SYS;PTM function. The FSO can also initiate requests for fire and adjustment of fire.

The first segment of the first VFMED module proposed covers a request for fire initiated by the Bn FSO and carried through to completion and reporting of the mission.

The second segment covers the monitoring of FO requests including fire missions that do not and do require FSO intervention, e.g., check fire.

As in the ACC first module, this VFMED module serves as an introduction to TACFIRE, showing the speed and simplicity with which fire missions are carried out. The student learns the VFMED console operations required to receive and transmit data and TACFIRE procedures required to obtain formats and completing and transmitting them to the FDC to request fire missions and to monitor and take action (check fire) on fire missions requested by the FOs.

Additional modules have been proposed for preliminary consideration covering the functions utilized by the Bn FSO. These are (including those in first module):

- SYS;FORM - Format skeleton request
- FM;RFAF - Fire mission - Request for additional fire
- FM;SUBS - Subsequent commands
- AFU;MFR - Non-nuclear mission fired report
- FM;QF - Quick response fire request
- FM;CMD - User commands
- SYS;PTM - Plain text message
- SYS;FSO - Fire support officer
- FM;OBCO - Observer location
- AFU;CMD - User commands
- SPRT;MAP - Map modification
- SYS;SBT - Subscriber table
- SYS;LGSB - Legal message type per subscriber
- SPRT;ZNE - Zone of responsibility
- ATI;CDR - Coordinate report
- ATI;SRI - Standing request for information

The modules developed will be modular, independent blocks of instruction. A number of these functions for preliminary consideration overlap those considered for the ACC. If, when the functions selected for training are finalized, the overlap of modules (or lessons within a module) remain, the modules developed for the ACC will be utilized for the VMED directly or adapted to fit the VMED operation.

The last module proposed for preliminary consideration covers the turn-on and check-out procedures for the VMED. This module includes the preliminary control settings for the DDT, ELP, Power Source and Power Junction Box, communication circuits, KG-31, and Display Editor; the power turn-on for the Power Junction Box, DDT, keyboard, and ELP and checks on the DE, DDT and ELP Fault indicators; checkout of the ELP, keyboard and DE; communication check, synchronization and loop test.



The purpose of this module, in addition to providing training on the turn-on and check-out procedures for the VMED, is to show the versatility of the AI method of instruction in providing breadth of coverage on all aspects of TACFIRE operations.

#### E. SUMMARY

In summary, the selection of preliminary functions for AI training has centered upon FDO and Fire Direction Sergeant operation of the ACC console and the FSO operation of the VMED.

The functions selected for preliminary consideration are as follows:

##### ACC

FM;DIR	AFU;DIR	SYS;DIR
*FM;RFAF	*AFU;UPDATE	SYS;PDS
*FM;SUBS	AFU;BAMOUN	SYS;FCM
*FM;QF	AFU;MV	SYS;SBT
FM;OBCO	AFU;AMOL	SYS;FSO
FM;FC	AFU;ASR	SYS;PCLD
FM;EOM	*AFU;MFR	SYS;LGSB
FM;CHECK		SYS;ADDR
	SPRT;DIR	*SYS;INIT
ATI;DIR	*SPRT;MAP	*SYS;FORM
*ATI;CDR	SPRT;DPM	
ATI;SRI	*SPRT;GEOM	
	SPRT;CMD	

##### VMED

SYS;FORM	FM;CMD	SPRT;MAP
FM;RFAF	SYS;PTM	SPRT;ZNE
FM;SUBS	SYS;FSO	SYS;SBT
AFU;MFR	FM;OBCO	SYS;LGSB
FM;QF	AFU;CMD	

The priority of functions generally follow the order listed, e.g., the FM function is considered the most important of the five functional areas shown for ACC operations. The asterisk (\*) indicates those items within the functional area considered to be the more critical. No attempt has been made to differentiate items in the VFMED area.

The approach to the selection of preliminary functions for AI training has been to select a broad coverage of areas, more than can be programmed for AI course development. It is expected that these functional areas will be reviewed by the U.S. Army Research Institute and other designated agencies and that final selection and prioritization of function areas will be made accordingly. This selection will furnish the basis for Phase II of this project, "Perform Job/Task and Training Analysis."

#### VI. RATIONALE FOR THE PARTICULAR INSTRUCTIONAL STRATEGY SELECTED

The instructional strategy is to teach the student within the context of the job. The instructional sequence presented will be the same as in the operational environment. Students will learn and apply what they have learned immediately. This application will be tested at frequent intervals throughout each lesson and at the end of each modular block. Failure to meet established criteria will result in repeating the lesson and/or module again. Repeated application and testing of what is learned throughout the course reinforce the learning that has occurred.

Another instructional strategy is to simplify the learning tasks into easily student-managed steps. The organization of course content and the steps required to progress through the course should not interfere with the learning process. It is incumbent upon the course designer to facilitate the learning process.

The question arises as to how a student can be trained without using the TACFIRE operational system. The results of the training should lead to the student getting onto the operational system and being able to physically put into practice what he has learned, i.e., the ultimate criterion.

In answer to this question, it should be noted that unmodified operating systems are not geared to training. It is difficult to stop the system to explain what is happening or what should be done next without affecting or changing the conditions - the standardization of training problem. However, simulation of the operating environment does allow this capability. Pictures of the equipment marked appropriately, are used to show the actions and sequences of actions required. Operational displays presented on the CRT are shown directly on the CRT or produced as off-line instructional aids. Copies of the ELP printouts are produced off-line and presented as required. This

controlled combination immerses the student in the operational situation in which console actions are taken and the results effected when these actions are accomplished. The TACFIRE computer and the PLANIT CAI system provide the controls, interactions and testing necessary to take the individual effectively through the learning process. Job-performance based testing of the individual at the end of each module reinforces the learning which has occurred and provides a visible measure of student achievement and satisfaction when he has successfully completed the instruction.

Another instructional strategy is in regard to error messages. In addition to covering error messages in the course, error messages will also be used as part of the feedback when invalid data is used to complete the message format, e.g., when entry of one field requires entry in a second field, the resulting error message generated by the situation will be used. This further ties together the relationship between actions taken and the error messages which result.

One more instructional strategy that has to be considered is in regard to format entries. It is expected that once field artillery personnel establish the relationship between TACFIRE format entries and data used in manual Field Artillery operations, it will not be necessary to cover every entry in a format, a time consuming and perhaps unnecessary process. Students will also vary in what entries they know, depending upon their previous experience. The instructional strategy used will be to provide the student with an opportunity to examine format entries and select those entries he is not sure of and receive an explanation of them. He can also select the option for a full explanation. This will reduce the course time required by the individual student and build upon what the student already knows.

A final instructional strategy is considered to make courseware independent of the device to be used. The three devices which can be used to display AI courseware are the ACC console, the VFMED console and the MIODS console (adapted to resemble the VFMED console). The console actions taken by the student to transmit his response to the computer differ. The strategy used in developing courseware, for the most part, will be to omit the actions required to transmit the response. Consequently, the courseware should be able to be run on any of the three consoles. Students will be furnished written instructions for the console used.

VII. OTHER FACETS OF EDUCATIONAL TECHNOLOGY GERMANE TO THE USE OF AI IN TACTICAL SYSTEMS

Several aspects of educational and training technology should be considered for application to the use of AI in tactical systems.

A. AUTOMATED PROGRAMMED INSTRUCTION (API)

Operational training has as its goal the actual use of the system to present the tactical situation, physically take the console action, monitor the action, determine whether it was right or wrong and provide feedback on the result. The system situations and console actions in training and the job are perfectly correlated.

Typically considered is on-the-job training using a skilled instructor paired with a student. While student time is not a serious consideration, the availability of trained instructors, standardization and evaluation of training, and availability of situations and disruptions to the learning process to set up situations present difficulties.

The API program for the USAF BUIC Air Defense System utilizes the operational console as the teaching medium and the operational system to generate displays. The API system as an adjunct to the operational system presents the instructional text, records the console action taken, compares the action with the correct action and provides feedback on whether the console action was taken correctly. This is done without affecting, changing, modifying or interacting with the operational system.

The use of such an adaptation should be investigated for tactical AI systems.

B. TORing

TORing (Training Operations Reporting) is a system used by the USAF Aerospace Defense Command to record the progress and decisions made during the conduct of an exercise. These data are reported at the end of the exercise to provide

a basis for identifying, discussing, and resolving problem areas disclosed by the exercises using the tactical data recorded during the exercise. The intent and result is to improve individual and team operations.

The development of this type of function is suggested as a method for improving tactical data system operation.

#### C. TRAINING FOR DIFFERENT ENVIRONMENTS

The Tactical Air Command uses System Training Exercises based upon locations and conditions in many different parts of the world. These exercises are used to "prep" operations personnel to operate in a particular environment and identify problems and solutions peculiar to the designated area of operations based upon the exercises run.

This capability should be investigated for use in tactical ADP systems including the development and loading of the data bases for the areas of operation and "firing" the missions in terms of battery locations and tactical situation.

#### D. TRAINING MANAGEMENT

A natural use of computers is to keep track of student training records, monitor student progress, direct students to their next requirement and provide reports for training personnel.

Several small systems are currently available. One of these is the Shipboard Training and Administration System (STAS) developed for the U.S. Navy Personnel Research and Development Center for use aboard Navy combatant ships.

The TACFIRE computer is programmable and has the necessary input and output devices for this function. Investigation of this capability for tactical systems is recommended.

## APPENDIX A

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